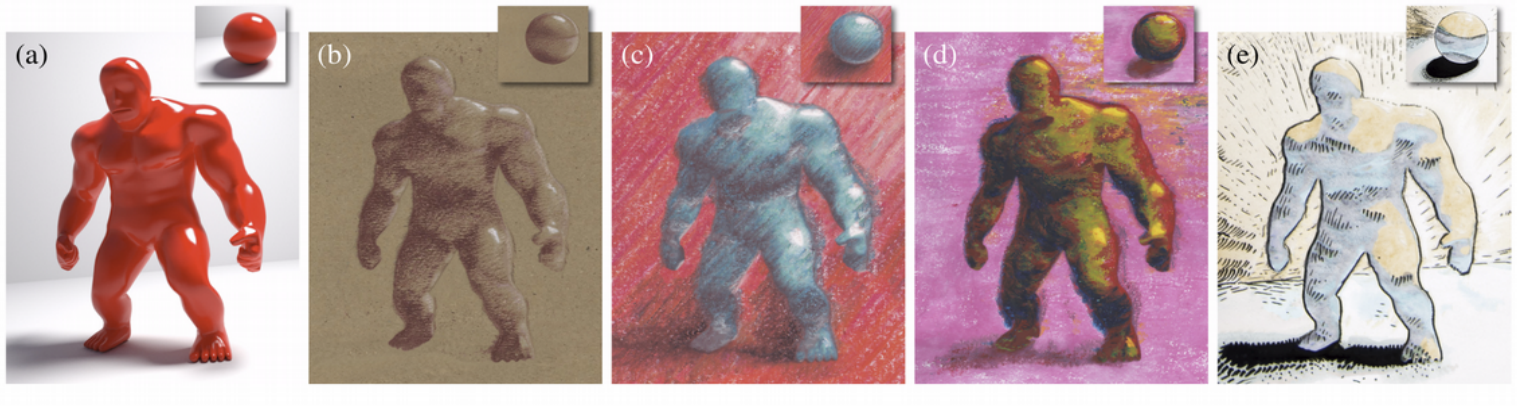
TELECOM ParisTech

SCIENCES SORBONNE UNIVERSITÉ

Illumination-Guided Example-Based Stylization of 3D Renderings

UE:IG3DA, Student: Mario Viti

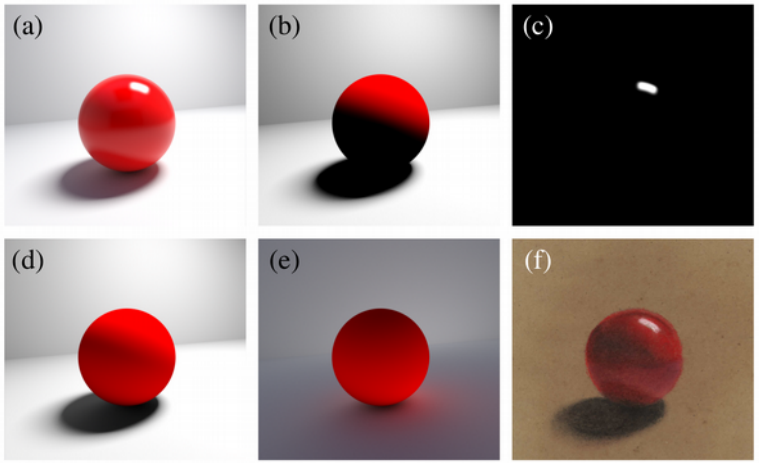
Stylit: Illumination-Guided Example-Based Stylization of 3D Renderings



Artistic hand made style

- Self Shadow
- Cast Shadow
- Indirect reflection
- Reflection highlights
- Color
- Texture

Light Path Expressions



*An example of a style exemplar with Light Path Expression images: (a) full global illumination render, (b) direct diffuse (LDE), (c) direct specular (LSE), (d) first two diffuse bounces (LD{1,2}E), (e) diffuse interreflection (L.*DDE), (f) hand-drawn style image. Exemplar image* © Daichi Ito.

- Separated Maps: Based on the fundamental property of “Physically plausible BRDF”

$$f(\omega_i, \omega_o) = f^d(\omega_i, \omega_o) + f^s(\omega_i, \omega_o)$$

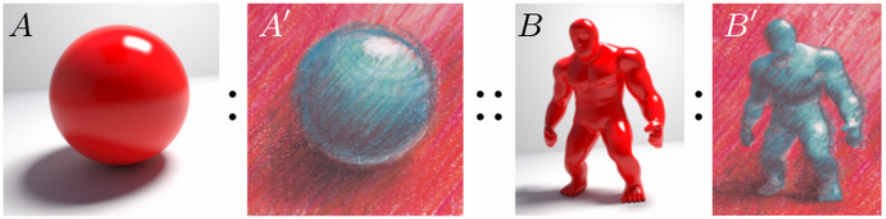
- Multiple Bounces diffuse:

$$L_o(\omega_o) = \sum_i L_i(\omega_o) f^d(\omega_i, \omega_o)(n\omega_i)$$

- interreflection: isolated Global Illumination term of indirect lighting Many options (Montecarlo,Radiosity,Surfels)*

* rendered with NVIDIA® Iray®

Image analogies



Source LPE : Source Style :: Target LPE : Target Style

- Analogies are defined by a global energy **A** = [*A*,*A′*], **B** = [*B*,*B′*]

$$E(\mathbf{A}, \mathbf{B}, p, q, \mu) = ||A'(p) - B'(q)||^2 + \mu||A(p) - B(q)||^2$$

- The Target result is the image **B** that minimizes the global energy

$$\sum_{q \in \mathbf{B}} \min_{p \in \mathbf{A}} E(\mathbf{A}, \mathbf{B}, p, q, \mu)$$

E-M optimization

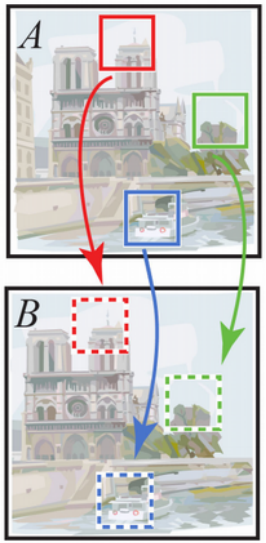
input : multi-channel images $\mathbf{A} = \{A, A'\}$ and $\mathbf{B}_k = \{B, B'_k\}$
output: synthesized target image B'_{k+1}

for *each pixel* $q \in \boldsymbol{B}_k$ **do**
  $NNF(q) = \underset{p \in \mathbf{A}}{\operatorname{argmin}}\, E(\mathbf{A}, \mathbf{B}_k, p, q, \mu)$

for *each pixel* $q \in \boldsymbol{B}_k$ **do**
  $B'_{k+1}(q) = Average(\mathbf{A}, NNF, q)$

- NNF: nearest neighbour field
(E STEP)
Assignment by averaging neighbourhood NNF(q) (M STEP)
B'_0 random initialization.

PATCH MATCH



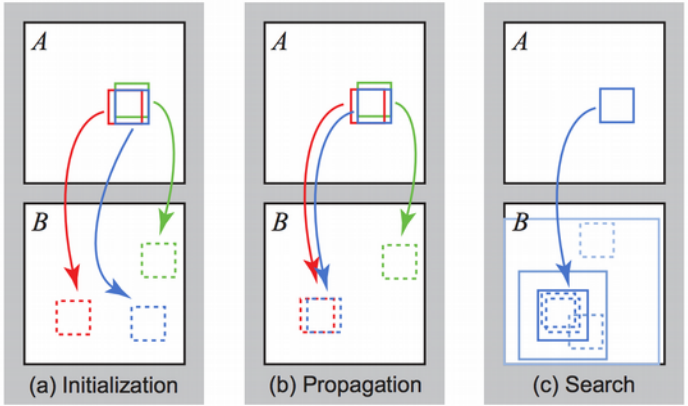
The algorithm alternates 2 main phases:

Propagation

Random search

PatchMatch: A Randomized Correspondence Algorithm for Structural Image Editing [C.Barnes, E. Shechtman, A. Finkelstein, D. Goldman]

PATCH MATCH



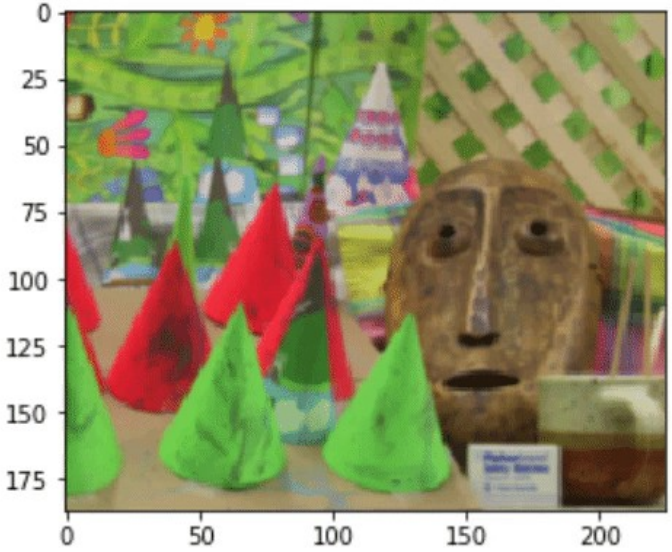
The algorithm alternates 2 main phases:

Propagation

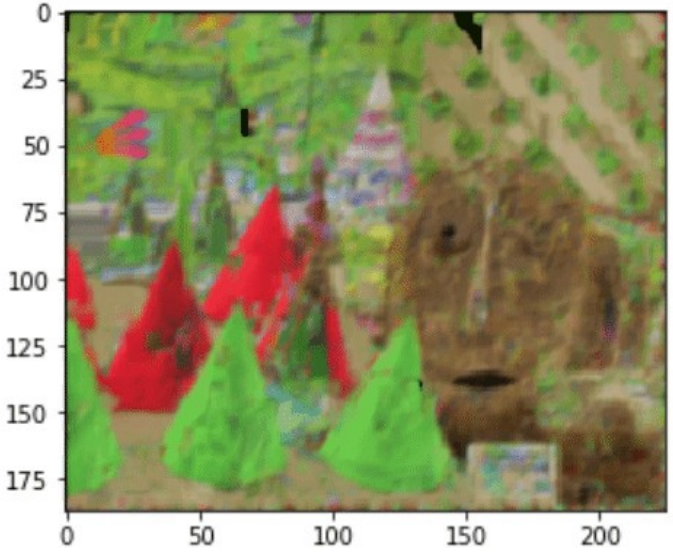
Random search

PATCH MATCH

It is used for example to estimate disparity within 2 similar image with a translational offset.



PATCH MATCH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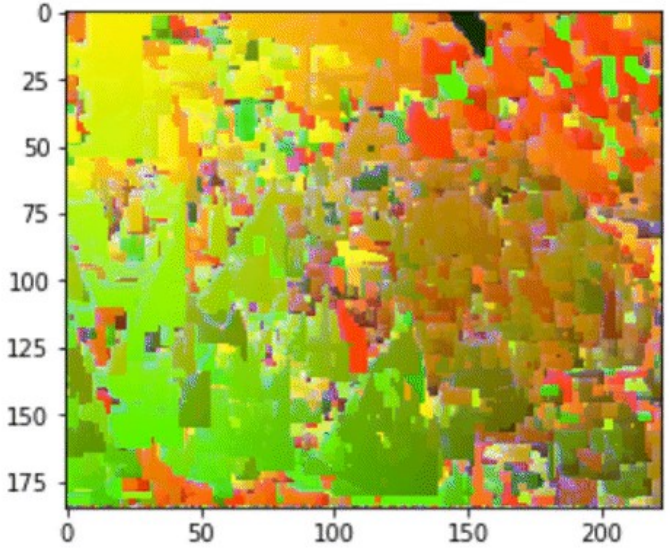
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IMPLEMENTATION

Languages/libraries:
python, c++, pybind, scipy.

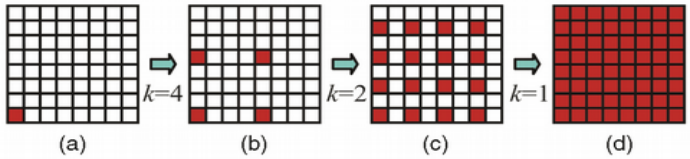
5 iterations on a 180x220 image
: 1.54 +- 0.02 sec

c++ - python wrapper library:

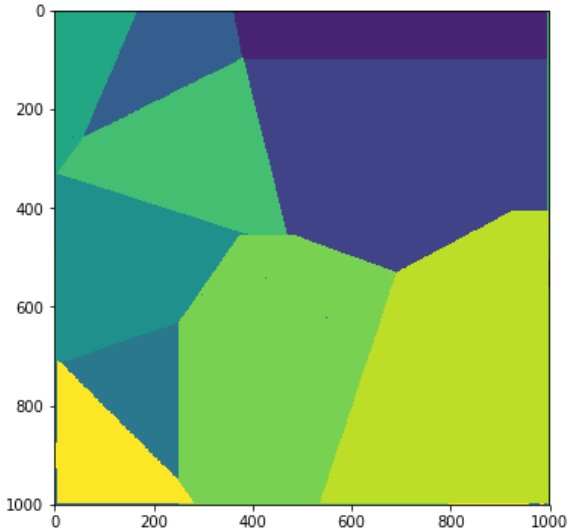
Pybind 11 hallows communication between python and c++ environments.

EXTENSION: JUMPING FLOOD

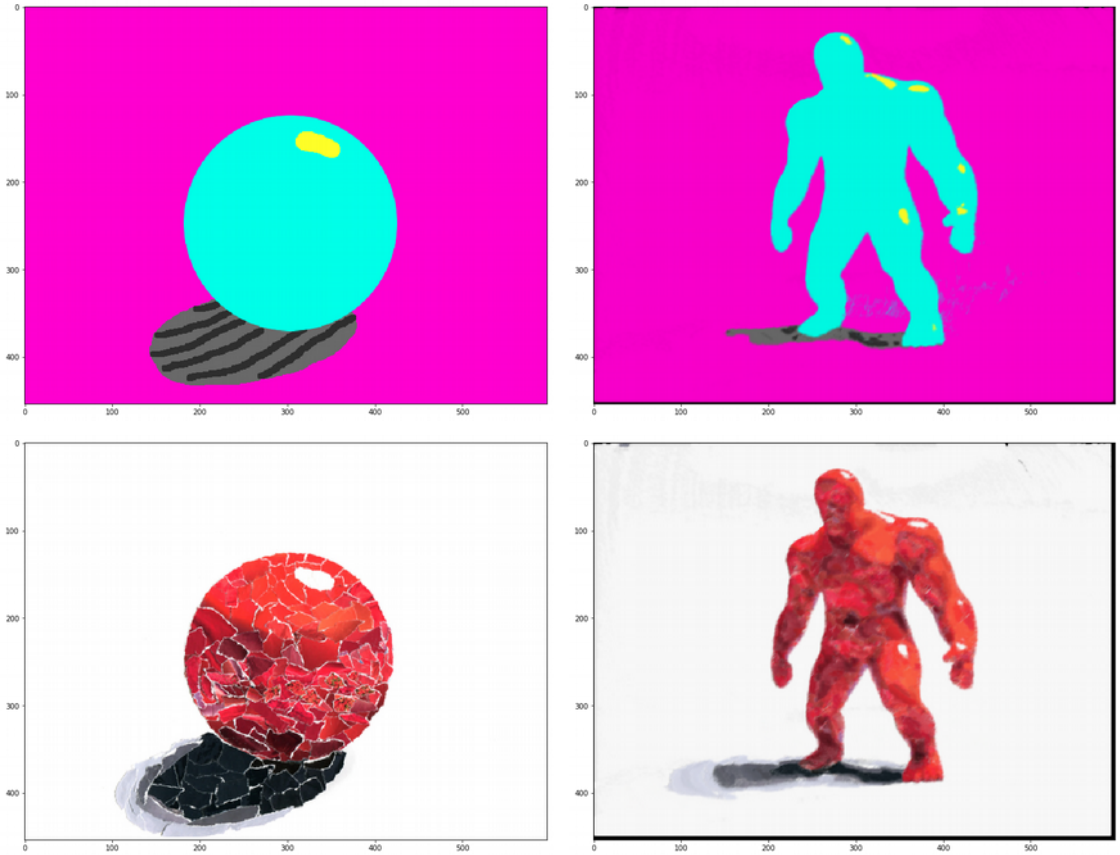
Efficient communication pattern for parallel applications.



a) seed position in red, non seed in white.
b) the seed communicates its position in a copy grid, non seed locations reading the communication and updating to nearest seed.
c) d) flooding occupies all the grid.



Jump Flooding in GPU with Applications to Voronoi Diagram and Distance Transform [G. Rong, T. Tan.]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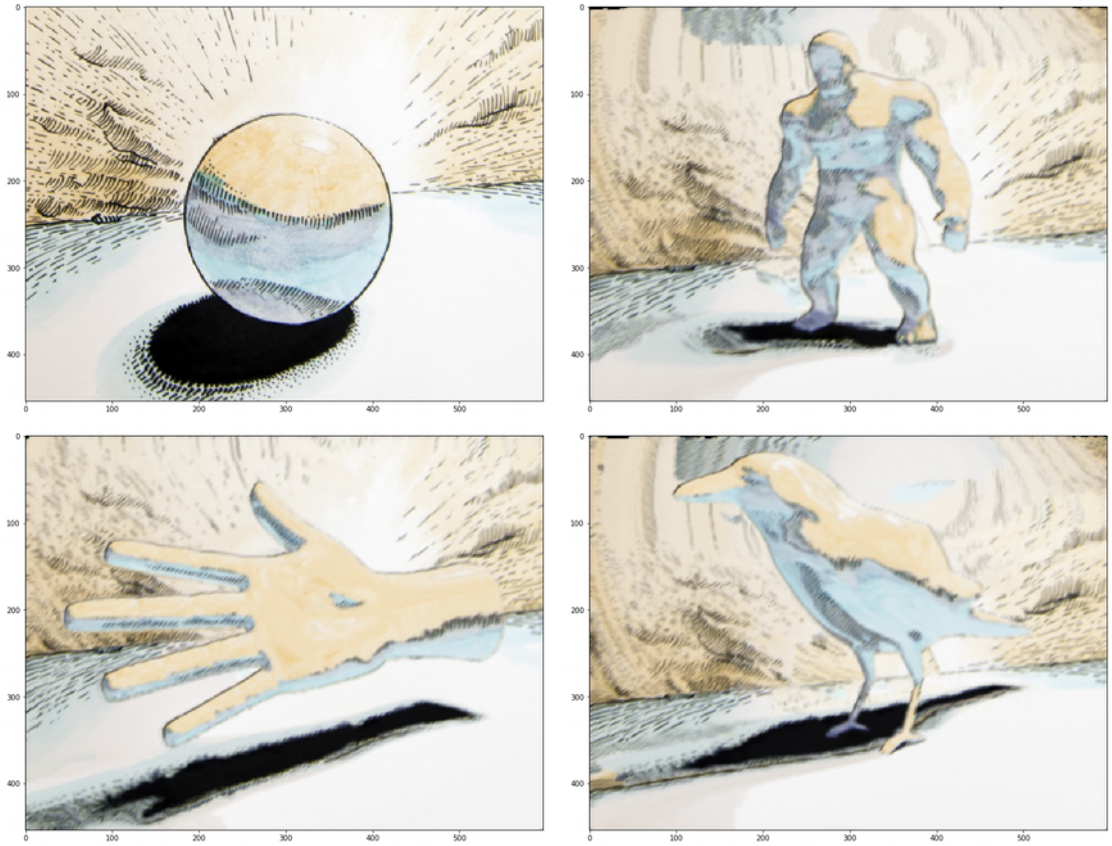
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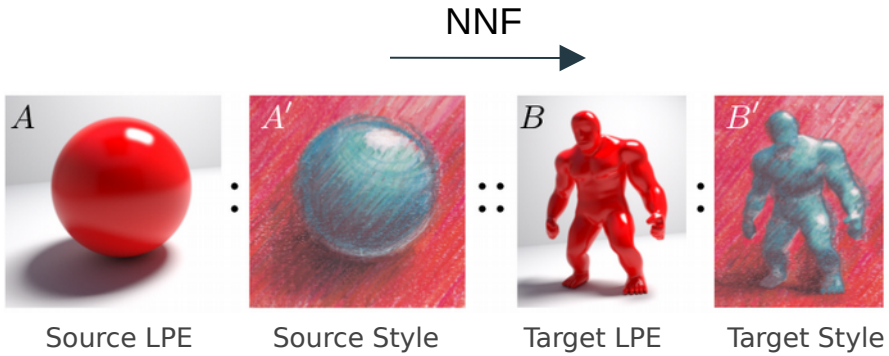
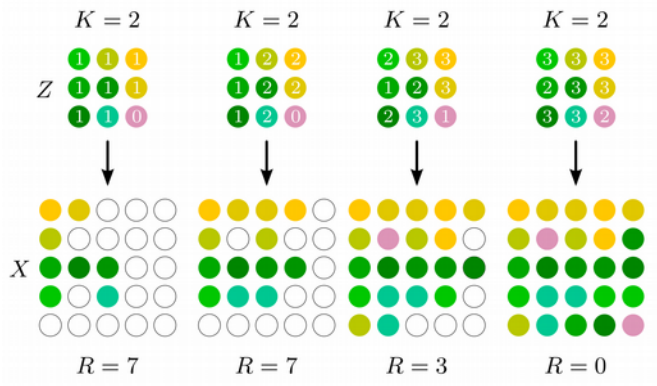
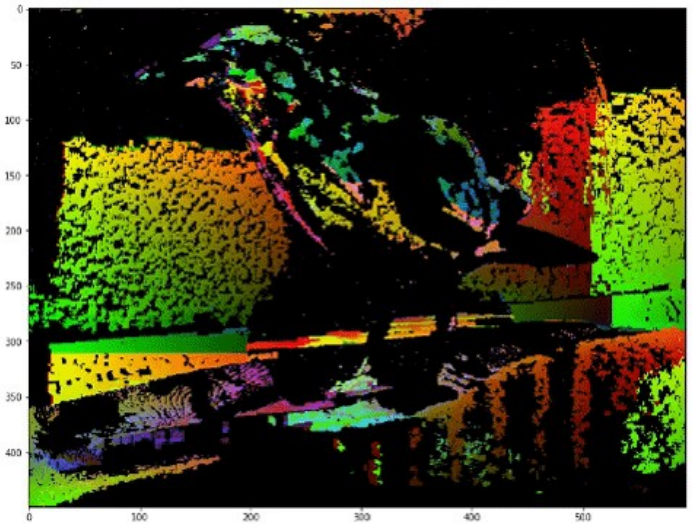
Reversed NNF

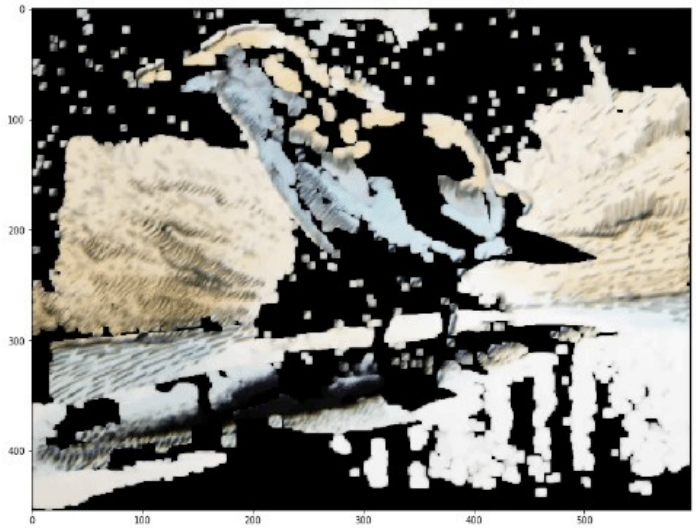




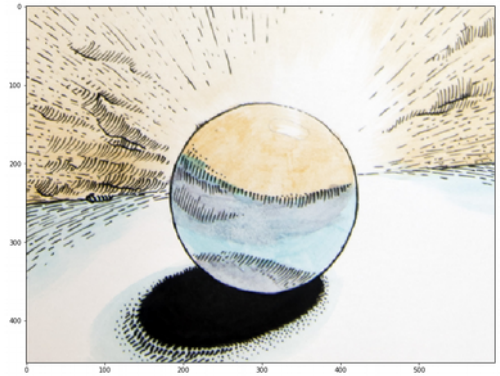
LazyFluids: Appearance Transfer for Fluid Animations [J. Fiser et al.]

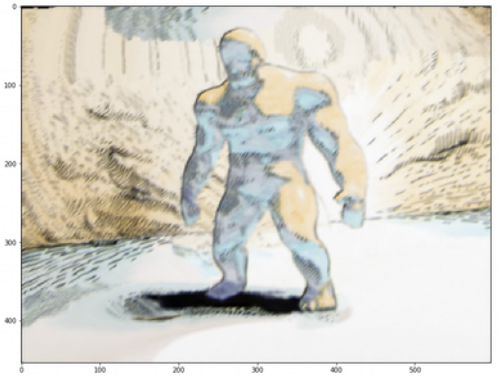
Reversed NNF

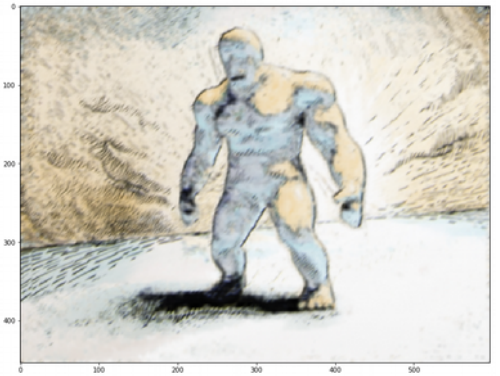




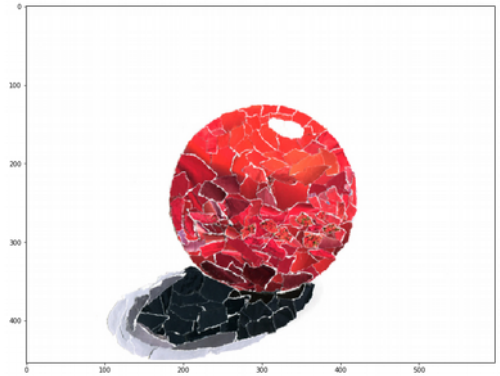
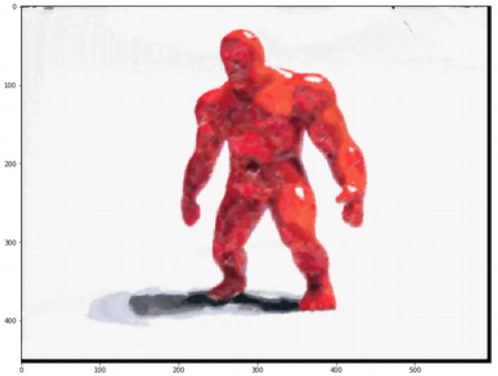
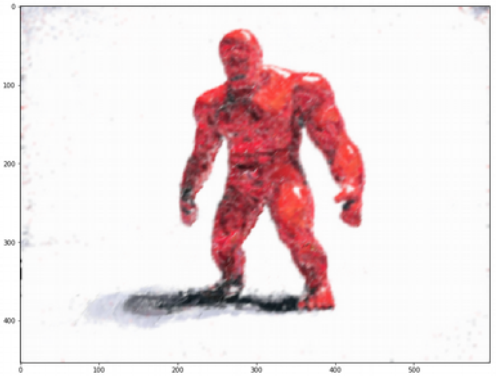
NNF vs ReversedNNF







NNF vs ReversedNNF

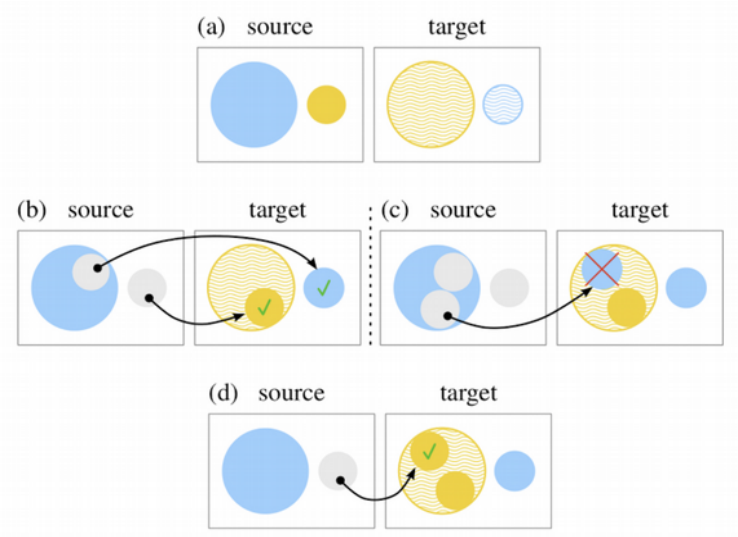
Uniform patch usage

A best matching target patch is retrieved for each source patch (b).

When scanning the source best matching location for patches in the target might be already covered.

This leads to erroneous assignments.

So one might want to reuse source patches.

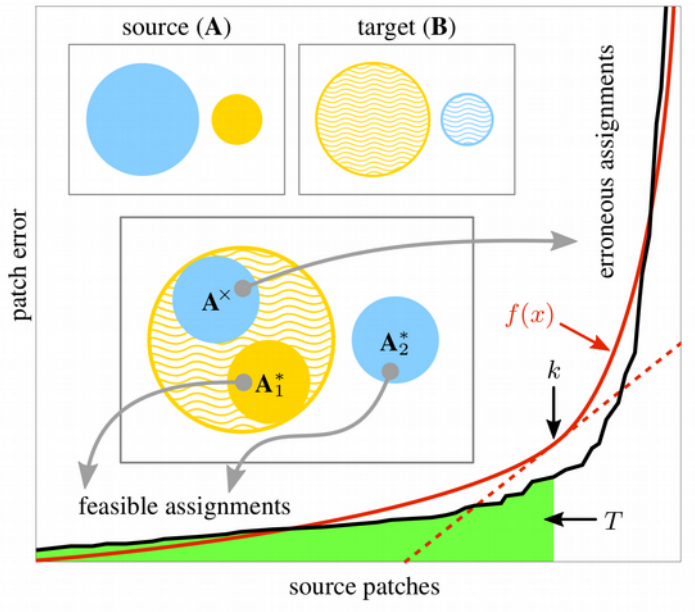


Uniform patch usage

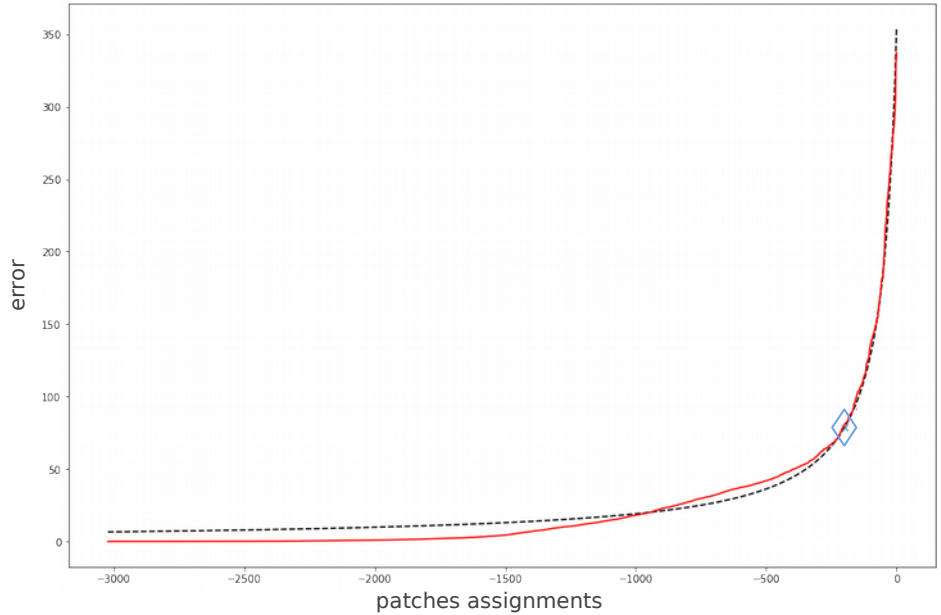
Enforce uniform patch by reversed NNF retrieval
[Jamriska Fiser et al.]

$$\sum_{p \in \mathbf{A}^*} \min_{q \in \mathbf{B}} E(\mathbf{A}^*, \mathbf{B}, p, q, \mu) < T$$

Apply this method correspond to the application of a Budget constraint on the Energy.



Assignments

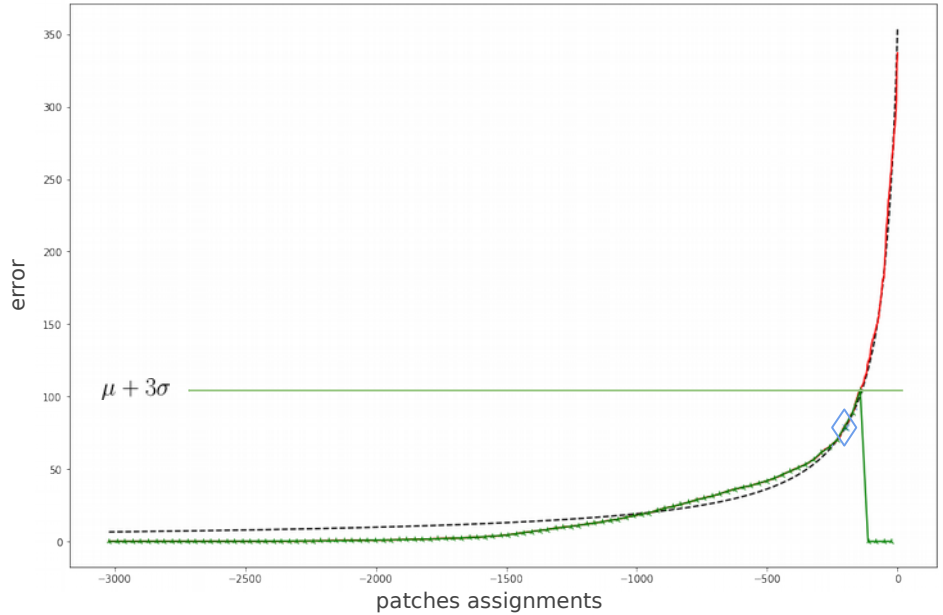


Same error is observed after reversed NNF retrival.

COMPUTATION:

sorting
hyperbole fitting

Assignments



Statistical approximated approach.

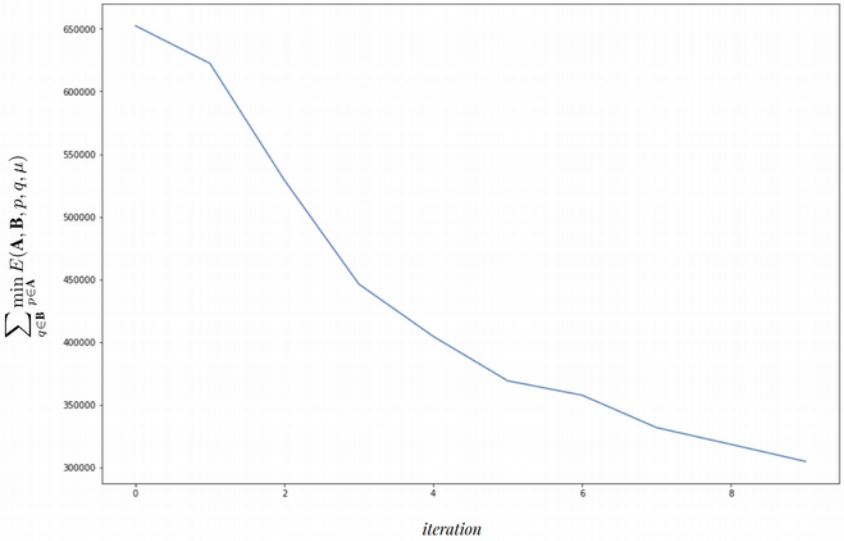
PROS:

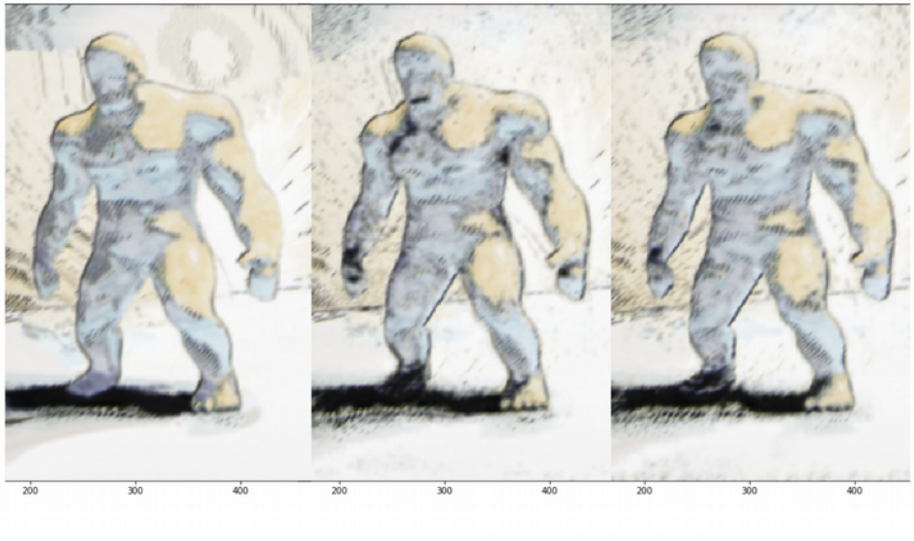
Save computation:
no need for sorting.

CONS:

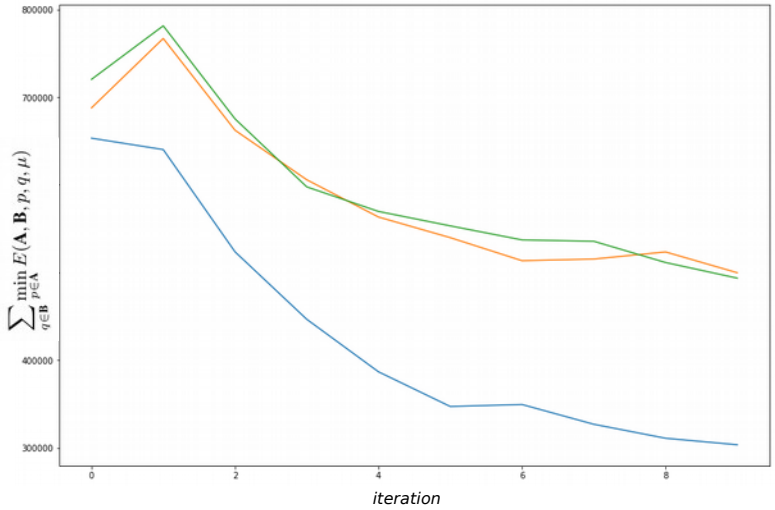
it is approximated (biased) by observations.

Energy minimization





EM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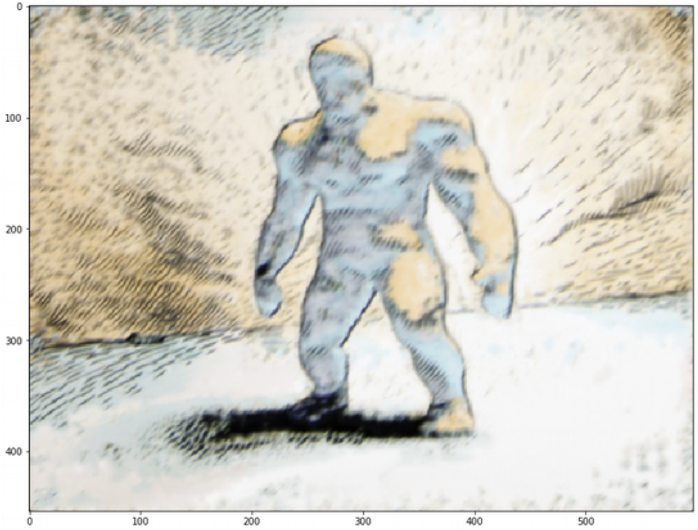
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Thank you.

References

StyLit: illumination-guided example-based stylization of 3D renderings, [J FIŠER, O JAMRIŠKA, M LUKAC, E SHECTHMAN, P ASENTE, J LU, D SÝKORA]

PatchMatch: A Randomized Correspondence Algorithm for Structural Image Editing, [C BARNES, E SHECTMAN, A FINKELSTEIN, D GOLDMAN]

LazyFluids: Appearance Transfer for Fluid Animations, [O JAMRIŠKA , J FIŠER , P ASENTE , J LU , E SHECHTMAN]

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